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Agricultural Research In New Hampshire

Annual Report of the Director of the New Hampshire Agricultural Experiment Station for the Year 1931

UNIVERSITY OF NEW HAMPSHIRE

Durham, New Hampshire

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AGRICULTURAL RESEARCH IN NEW HAMPSHIRE

Annual Report of the Director of the New Hampshire Agricultural Experiment Station for the Year 1931

J. C. KENDALL, *Director*

In times such as these every public agency must feel more keenly than ever the duty to fulfill its public trust: to return to the general good a greater sum in ultimate values than it has taken out. Such return is often difficult to measure accurately, especially in the research field, where we must often grope and fail. But it is only through constant experimentation that agriculture has advanced to its present levels, and only by the same means can we continue to progress.

If public research seems costly, one may well consider how much more expensive and frequently impossible is research on the part of the individual farmer. And if public research seems inconclusive at times, it must be remembered that the observations of lone and untrained men would be hopelessly so. Civilization is committed to the laboratory and to trained research; and the pathway ahead out of economic depression would only be the darker if they were withdrawn.

The past year has seen several important projects to a stage where conclusions could be drawn; among them, our economic fruit farm studies, the survey of Grafton County dairy farms, Boston milk consumption study, contact-insecticide project, study of root growth of white pine, studies in human nutrition, land utilization study, spray residues project, head lettuce investigation, etc. The following pages will give some details as to the significant results of the year.

In the meantime it has been possible to develop several important new studies. The dairy situation in New England is acute, and one of the pivotal questions is the relative cost of Grade A as compared with Grade B milk. We are conducting a study of the practices and factors affecting marketing costs and quality of product. Of equal importance to the dairy industry should be a series of efficiency studies in the Connecticut Valley, dealing with dairy farm organization and production practices. With the completion of these projects, as well as of the Grafton County survey, previously noted, the Experiment Station should be in a position to give new counsel that will be welcome to many dairymen throughout the state.

Other new investigations deal with coccidiosis of chickens, which has proved one of the most menacing of poultry diseases during recent years; and further development of the land utilization question; a beginning of definite Record of Performance work for poultry breeders was also made.

The staff suffered a real loss during the year in the death of Philip R. Lowry, assistant entomologist, who had been with us for ten years and who died suddenly April 29 while engaged in his laboratory work.

Mr. Lowry was still a young man and had been a most conscientious and reliable investigator. His place has been taken by James G. Conklin, B. Sc., Connecticut Agricultural College, M. Sc. University of New Hampshire and for the last two years a graduate student at Ohio State University. Otherwise the staff has remained intact during the year except for the resignations of H. O. Stuart, assistant poultryman and Maurice Bickford, assistant in animal nutrition. A. E. Tepper, poultry certification inspector, has been appointed in Mr. Stuart's place; and Frank Reed, who has completed the field work in economic poultry farm studies, will take charge of the certification and Record of Performance program. Harry Murray completed his graduate work in the Botany department, and his place has been taken by Russell Bissey. Clarence Winchester and Lloyd E. Washburn have been appointed graduate assistants in animal husbandry; and S. J. Fisher as graduate assistant in agricultural chemistry.

New publications were issued during the year as follows:

Bulletin 252—Results of Seed Tests 1930.
" 253—Inspection of Commercial Feeding Stuffs, 1930.
" 254—Inspection of Commercial Fertilizers, 1930.
" 255—Land Survey of the Town of Durham, New Hampshire.
" 256—Agricultural Research in New Hampshire, 1930.
" 257—Studies in Economics of Apple Orcharding—Part I, An Apple Enterprise Study—Costs and Management.
Circular 35—Top-Dressing Old Pastures.
" 36—Remodelling Farm House Cellars for the Storage of Potatoes.
" 37—Consumer Preferences for Potatoes.
Technical Bulletin 44—The Relation of Hydrophilic Colloids to Hardiness in the Apple as Shown by the Dye Adsorption Test.
" " 45—The Heat Production of Sheep Under Varying Conditions.
" " 46—A Numerical Rating for the Contact Performance of a Spray Material.
" " 47—Some Results of Inbreeding on Fecundity and on Growth in Sheep.
Scientific Contribution 28—Maintaining Cultures of Mosquito Larvae.
" " 29—Pollination Studies with the McIntosh Apples in New Hampshire.

Fruit Farm Studies

That portion of the economic study of fruit farms relating to costs and management from an enterprise point of view was completed during the year by H. C. Woodworth and G. F. Potter, and the results published in Bulletin 257.

Briefly, it was noted that on account of skill required, on account of expensive spray equipment and spray material and on account of the short but very definite spray periods, spraying is the most important operation from the management angle. Good yields are important in

low cost per bushel; good yields are not correlated with intensive methods of pruning and caring for trees. There are indications that site or pollination or both may have more influence on yields than just methods.

The other phases of the study are in process of development.

On ten selected fruit farms in 1926 the average labor income was $80; in 1927, a year of good prices, the average labor income was $2,777 on 12 farms, and in 1928, it was $843. The average labor income for the three year period was $1,336.

Approximately 18% of the total time reported on these farms was used for miscellaneous items such as repairing buildings; work on new and old equipment; directing men; conferences with machinery, equipment and fertilizer salesmen; record-keeping; credit problems, etc. *(Purnell Fund)*

Roughage Costs

Records of silage production have been studied by M. F. Abell on 280 New Hampshire farms as a part of the roughage production costs. Silage corn averaged 7.5 acres per farm, constituting nearly 12 per cent. of the tillage area. The farms were somewhat larger than ordinary, as is indicated by the fact that they averaged 21 cows and 13 head of young stock. Average yields of silage amounted to 11.6 tons per acre from 10.9 quarts of seed. Crews averaged 5.5 men. Influences of various practices are being summarized and will be discussed in a separate publication.

Hay records were studied on 328 farms. Permanent hay land averaged 46.6 acres per farm and annual hay land 4.7 acres.

Nearly 50 per cent. of the grass seed is timothy. The need for a better quality roughage indicates the possibility of a reduction in timothy by probably 15 per cent. and the substitution of some more legumes. The rather large area in annual hay consists quite largely of oats or oats and pea hay which is used as a "nurse" crop. The oats that in the past were largely cut for grain are now cut earlier for hay. How great the expansion of this annual hay crop, considering the high seed and labor cost for a yield so little larger than that of permanent hay, raises many questions. Its use at present is almost entirely as a crop in which or with which to seed for permanent hay.

The large amount of manure used is accounted for partly by its application to the annual hay crop, and for top-dressing new seedings after the removal of the annual crop. Very little commercial fertilizer is used on hay as yet. *(Purnell Fund)*

An Extensive Study of New Hampshire Poultry Farms

Pullets produce eggs cheaper than old hens by seven cents per dozen with grain worth $40 per ton, according to a study of 23 commercial poultry farms in the state. While the old hens ate slightly less feed than pullets, their production percentage was much lower. Feed consumption per dozen eggs was 8.7 pounds for pullets and over 12 pounds for hens.

The research also indicated that if a poultryman hopes to house 300 pullets in the fall, he needs to start approximately 700 baby chicks. And he will require about $135 in cash to finance the venture the first five months, in addition to the amount he spends for the chicks and for labor.

This phase of the investigations is particularly important, due to the fact that the average New Hampshire poultryman replaces from 75 to 100 per cent. of his laying flock each year. The study covered a one-year period and included 18 flocks with 63,300 chicks started and over 26,700 pullets raised to maturity. Out of each 100 chicks started 42.26 pullets were housed.

Total costs up to the time of housing each 100 pullets amounted to $208.84, 48.3 per cent. of which went for feed, 22.7 per cent. for chicks, 14.8 for labor, 3.0 for fuel, 1.2 for litter, and 9.1 for interest, depreciation, taxes, and insurance.

Credited to each 100 pullets at housing time were $77.61, representing the income from broilers, roasters, pullets and breeding cockerels, and started chicks. Deducting this from the total expenditures leaves a net cost of $131.23 to put 100 pullets in the laying pens at 21.8 weeks of age.

The detailed study of the 23 farms will be ready for publication shortly and will include data on financial income and outgo, distribution of egg sizes by age of pullets, weekly egg production and grain consumption of pullets by pens, weekly mortality and culling, weekly egg production and grain consumption of old hens, and total grain consumption of growing pullets.

It is hoped that it will throw light on such problems as what is the best time to hatch chicks to secure greatest returns and to what extent it is economic to cull laying stock under different situations as to price of grain and eggs.

H C. Woodworth and Frank D. Reed have been in charge of the project, with Mr. Reed giving full time to it. *(Purnell Fund)*

Dairy Survey in Grafton County

With reasonable price conditions, the two most important needs of the Connecticut River dairy farms in Grafton county are to improve the production of the dairy cows and increase the number of them on each farm.

This is according to a survey of approximately 400 farms in 15 out of the 39 towns in the county by M. Gale Eastman. The results have been published in Bulletin 260, "An Economic Study of Dairy Farming in Grafton County, New Hampshire, 1930."

Higher quality cows need to be obtained, either through breeding or by purchase. The average production at the time of the survey was only 5,150 pounds of milk.

Probably the most desirable business unit in this area is from 30 to 60 cows. This would mean a large farm, a good labor organization for from two to three men and modern labor-saving machinery and conveniences. These are now reasonably large businesses with an av-

erage of 16 cows and 233 acres of land per farm for the whole group.

Labor incomes for 395 of the farms averaged $393. The highest income was over $5,000.

In a region selling whole milk almost exclusively, average labor incomes are likely to be low because dairying tends to be overdone. This condition is augmented in Grafton county because of the ease with which outlying farms already provided with livable buildings can be bought or hired. *(Purnell Fund)*

Efficiency on Dairy Farms

Following the dairy survey in Grafton county detailed efficiency studies have been conducted on 50 of these farms in cooperation with the Bureau of Agricultural Economics. Charles Harris, stationed at Woodsville, is giving his entire time to the project in consultation with H. C. Woodworth, Max F. Abell of the New Hampshire Station and Emil Rauchenstein of the United States Department of Agriculture.

The pastures on each farm have been roughly studied and different areas classified. Of the 4,623 acres in pasture, 252 acres or 5.4% were found to be old tillage land, 467 acres or 10.1% were good soil and were free of brush, 773 acres or 16.7% were good soil but were not plowable and had grown up to brush. All the rest of the areas were of little value as pasture and could not be made into good pasture in any practical way. Thus, in this area, only about 30% of the pasture area has any particular potential value as pasture.

On the individual farms, the amount of potential good pasture varied greatly. One farm, for instance, had 70 acres of potential good pasture; another only 7 acres. These circumstances, no doubt, have a marked influence on ability of farmers to make cheap milk. *(Purnell Fund)*

Potato Marketing

One hundred thousand fewer bushels of potatoes were shipped into the state last year than in 1925, according to a check-up of railroad receipts by E. H. Rinear. The study, which covered the period September 1, 1930 to June 1, 1931, revealed the fact that 140,723 bushels were shipped into the state as table stock during that period. A similar study (New Hampshire Station Bulletin 222) made in 1925 showed there were 240,020 bushels shipped in during a shorter period, namely from October 1 to May 1.

It was learned in a house to house survey that much variation exists between nationalities and incomes as to the size of potato preferred and the definite qualities desired. The results of this investigation have been published in Circular 37, "Consumer Preferences for Potatoes." Because of this information, there is a decided tendency for growers to grade more carefully and to eliminate many of the objectionable features which had been previously disregarded.

A new problem was discovered last year about the Concord area, where an over-supply of potatoes was being forced on the market so that prices were greatly depressed. The growers about Concord had

greatly increased their production during past years but had not looked for new marketing outlets. Seventeen miles away in Manchester, 56,000 bushels were shipped in from Maine. Furthermore, the price differential between the two cities averaged $.09 a bushel lower in Concord than Manchester. It seems safe to assume that if the surplus about Concord had been trucked to Manchester, it would have raised the price in Concord to about the Manchester level.

The improvement of marketing methods and development of New Hampshire markets are being gradually brought about by a number of forces working harmoniously. The development has been advanced by production cost studies, field demonstrations, better seed and the adoption of standard grades. The New Hampshire Farm Bureau Federation is serving as a clearing house between growers and regular trade channels. *(Purnell Fund)*

Milk Marketing

A study of the practices and factors affecting marketing costs and the quality of milk produced on New Hampshire farms was initiated last year by E. H. Rinear and H. C. Moore. It deals particularly with the costs of the various methods in marketing Grades A and B milk, in order to learn the most economical way of caring for milk in preventing bacteria development from the time it is drawn until it is delivered to the consumer.

The project naturally divides into three parts: first, that performed by the farmer when milking, cooling and transporting to the receiving station; second, the assembling and care of milk preparatory to shipping in tank cars to Boston; third, the part played by the wholesale and retail distributor before the milk is delivered to the consumer.

To date, detailed information has been obtained from 42 farms regarding the amount of equipment, method of washing and sterilizing equipment, time required and annual cash outlay for making Grade A milk. *(Purnell Fund)*

Soil Fertility Studies

Six experiments in this field under the Purnell Fund are being supervised by Ford S. Prince and Paul T. Blood, with chemical work done by T. G. Phillips and G. P. Percival. One phase of the work under way is the annual sampling and testing for pH value of each plot.

The *Experiment with Hay on Neglected Hay Lands* on the Whenal farm, Greenland, N. H., has now run six years. The work as originally planned is finished and will be reported in a separate publication shortly.

There are 63 twentieth-acre plots in the experiment, 12 of which represent the original sod, 24 having been plowed and reseeded with manure, the remainder plowed and reseeded without manure.

Nitrate of soda has given a significant increase on the manured and unmanured sections but has failed to do so on the unplowed plots.

Superphosphate has not given a significant increase in the experiment when used alone.

The combination of nitrate of soda and superphosphate gave a significant increase on the manured and unmanured sections, although as in past years this increase must be ascribed mainly to the nitrogen rather than the phosphorus used.

The increases recorded for lime are significant for both the two and four ton applications. It is quite evident that the original pH of this soil is too low for the maximum production of grass hay.

On the alfalfa plots in the *Experiment with Legumes on Neglected Hay Lands* it is quite evident that potash has the greatest influence in stimulating growth; phosphorus stands second in this respect, particularly where it is used on heavily manured plots; and nitrogen ranks third, its beneficial effects decreasing where it is used on the heavily manured plots.

The benefits of extra lime are more marked when used with heavy manure and fertilizer applications.

The value of the manure on the plots receiving an extra quantity, although six years have elapsed since its application, is still quite marked.

In the *Experiment with Potatoes in a Rotation* on the Jackson farm, near Colebrook, the field is divided into three parts of about 50 twentieth-acre plots each; and potatoes, oats and alsike clover are grown each year on different sections of the field in a three year rotation.

Various fertilizer treatments are applied only to the potatoes in this experiment. Lime has been applied once on those plots receiving that material.

The yield of potatoes in 1931 was unusually heavy. The check plots i. e. those receiving a ton of 5-8-7, averaged 445 bushels per acre. Although all the elements that were added to the 5-8-7 formula in individual instances increased the yield, in no case was the increase significant.

Decreases on those plots where the phosphorus and potash were omitted were larger than in former years. This may be explained by the fact that in 1931 the rotation entered its second course, potatoes having been grown on these same plots in 1928 and treated the same. There may be some accumulation of phosphorus and potash in the soil on plots supplied with that element; but in case it is omitted entirely from the fertilizer it seems likely that the deficiency is magnified.

In the *Experiment with Legumes in the Connecticut Valley,* eighty plots are located on the Livingston farm near Claremont.

In this year's results all of the treatments having lime or potash in combination with some other fertility factor are significant. In addition to this, potash alone in the first cutting has given a significant increase.

It is interesting also to note that the series of plots getting NPK or a complete fertilizer treatment is one of the highest yielding of the entire group.

Pasture Top-Dressing. A new series of sixteen eighth-acre plots was laid out in the spring of 1931 on an area of old pasture land belonging to Seavey Bros. near Greenland, N. H. One half of each plot was limed, except those plots receiving lime-bearing fertilizers.

Fertilizers were then applied according to the plan of the experiment, including a test of different phosphorus and nitrogen carriers, a comparison of annual and triennial applications of phosphatic and potassic fertilizers as well as a check-up on ready mixed vs. home mixed materials. *(Purnell Fund)*

Time of Cutting Hay

Harvesting was started June 10 and continued at ten day intervals until July 30 on a series of hay plots on the University Farm in order to determine further the best time of cutting.

After each harvest the hay from the plots was transported to a drier, especially constructed for this purpose, and evaporated to an air dry basis.

The grass hay had the greatest amount of protein on June 10, the greatest percentage on June 10, but did not reach the heaviest yield of hay until July 20.

A second cutting made on September 2 proved that cutting as early as June 10 under Durham conditions does not lower the yield of the rowen. The work was done by F. S. Prince and P. T. Blood. *(Hatch Fund)*

Fertilizer with Potatoes

A series of fertilizer tests conducted over a period of years on potatoes by F. W. Taylor has shown the following facts:

Varying grades of potash in a nine-year average have produced the following yields per acre on clay soil: 4-8-0, 214 bushels; 4-8-3, 239 bushels; 4-8-6, 263 bushels; 4-8-10, 268 bushels; check 161 bushels.

Placement tests above, below, at the side of, and with the seed in a five-year average have shown a difference of only seven bushels in the yield. In three years the lowest yield has been with the fertilizer above the seed; but last year, due probably to heavy rains after planting, this placement showed a higher yield by 26 bushels than any of the others.

Manure, applied at the rate of 12 tons per acre, has given yields in a 5-year average of 225 bushels, compared with 260 bushels for a 24-ton application and 140 bushels for the no-manure plots. At the 12-ton rate the manure has been worth $8.17 per ton on the average, at the 24-ton rate, $5.61.

Sulphate of ammonia in the 4-8-4 fertilizer in a four-year average does not show up as well as does nitrate or a mixture of sulphate and nitrate. Yields have averaged: Nitrate, 280 bushels; mixed, 279 bushels; sulphate, 264 bushels.

A concentrated grade, 16-32-16, or Nitrophoska, has given nearly as good results as four times as much 4-8-4. In a four-year average the former yields have run to 264 bushels and the latter to 279 bushels. While the average yield has been about 15 bushels less, it should be remembered that the concentrated fertilizer costs less per unit of plant food. No injurious effects upon the plants have been noted from its use. *(Hatch Fund)*

Fertilizer Placement for Corn

Tests carried on by 23 state experiment stations, of which New Hampshire was one, seem to indicate that the most strategic placement of fertilizer for corn is in narrow bands on each side of the hill at or above the level of the seed.

Seven different placements and rates of application were tried. Every third plot was a check, and the series was duplicated five times. Yields ranged from 64 to 76 bushels per acre in the tests conducted here by F. W. Taylor. *(Hatch Fund)*

Sheep Breeding Experiments

The result of systematic inbreeding of sheep on fecundity and on growth rate indicates that continuance of this practice is followed by a strong tendency toward decadence in most inbred groups, reports E. G. Ritzman.

Of thirty-six different family groups which were inbred there was only one group in which the standard of fertility and of growth rate did not diminish during four generations of inbreeding. In most family groups there occur individuals of superior merit, but the number of inferior members outnumbered the good ones.

Inbreeding served as a clarifying agent by bringing undesirable recessive characters to the surface so that the animals possessing them could be weeded out.

By rigid systematic selection of animals kept for breeding through succeeding generations the standard of fecundity and of adult size was easily maintained, but in the fourth generation the flock was composed almost entirely of one family line.

The results also emphasize the corollary point that under the present standards of flock management it is the general practice to change rams often and thus to avoid inbreeding. In essence it amounts to outcrossing, which brings about the formation of heterozygous traits.

Undesirable recessive characteristics are thus not eliminated. They are simply covered up. These latent characteristics, being unobserved, tend to become homozygous, and so by inbreeding come to the surface in succeeding generations. This has been amply demonstrated by the lack of uniformity which characterizes the membership or composition of most of our breeding flocks. *(Adams Fund)*

Nutrition Studies

Dairy Cows

The nutrition studies, conducted in cooperation with the Nutrition Laboratory of the Carnegie Institute of Washington, have included this year a number of digestion experiments and of metabolism measurements with three Holstein cows to determine the net energy for maintenance of various feed-stuffs in common use. These feed-stuffs include alfalfa hay, timothy hay, hominy feed, oats (ground), wheat, bran, and gluten feed. The results (with the exception of alfalfa hay and gluten feed) correspond closely with the net energy values given

by Armsby for these same feed-stuffs, report E. G. Ritzman and F. G. Benedict. Since the possibility of measuring the net energy value of individual feed-stuffs has recently been challenged, it will be necessary to repeat much of this work as a matter of routine before the results can be definitely accepted.

In connection with the digestion balances a material progress has been made by further improvement of the apparatus for the separate collection of feces and urine from cows. Tests with artificial and with natural urines have shown that the loss of nitrogen during a 24-hour period can now be held under two per cent. *(Purnell Fund)*

The Metabolism of the Horse

Metabolism measurements were made on three horses during the year. Except for the work of Zuntz (1894) using a tracheal canula, these are, so far as we are aware, the only direct metabolism measurements carried out on this species.

The fasting metabolism of the three animals while standing was respectively 2,669, 2,206, and 2,000 calories per square meter of body surface, giving an average of 2,292 calories. With a deduction of 25 per cent. for the effort of standing we have a basal metabolism of 1,719 calories, which indicates a materially higher basal requirement than that of any other farm live stock and approximately double that of man. The high metabolism characteristic of the horse is that of a tensely nervous animal that does not easily lay on flesh and represents a high degree of metabolic activity which is in full keeping with its muscular power and the capability of almost explosive activity.

A study of the changes in the respiratory quotient during fast indicated that the two horses which subsisted on pasture up to the experiment had exhausted their stored carbohydrate (glycogen) in about 48 hours, but the horse which was fairly heavily grain fed did not exhaust his stored carbohydrates until about 100 hours after the last food had been consumed. This large carbohydrate reserve which the horse can store up explains his well deserved reputation for muscular endurance. *(Miscellaneous Income)*

The Effect of Castration on Energy Metabolism

Metabolism measurements made on both sheep and a pig before and after castration indicate a lowering of the maintenance requirement and thus a greater efficiency in flesh storage following the operation. *(Miscellaneous Income)*

Food Wastes Studied

How far modern eating practices have strayed from the gospel of the "clean plate" is shown in the study of edible food wastes completed by A. Gertrude Farr in cooperation with Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution of Washington. It was found that students at college fraternity and sorority houses sent back uneaten an average of 3 to 21 per cent. of the calories served, and as high a percentage of the protein. The principal reason, aside from personal likes and dislikes, is found in their consumption between meals of extra foods—chocolate bars, pea-

nuts, marshmallows, jam, etc. Confections of this type run much higher in fuel value than is ordinarily supposed, and accounted for from 13 to 29 per cent. of the total energy intake of the day.

Improved methods of using the oxy-calorimeter in determining energy and protein content of mixed meals were developed.

The amount of waste was found to vary greatly with the individual and also with the fraternity houses. At one sorority house, a newly organized group of women trying to keep their expenses at a minimum wasted only 3 per cent. of the energy content and 4 per cent. of the protein content of the purchased food served. The results of the study have been published in Bulletin 261. *(Purnell Fund)*

Control of Apple Scab

Calcium sulphide, which has given promising evidence in control of apple scab in Virginia orchards, does not work so satisfactorily under northern conditions, finds O. Butler. In a comparison of it with lime sulphur on McIntosh, plots were sprayed five times. Calcium arsenate was used at the rate of 1 pound to 50 gallons of solution when an arsenical was required. The trees sprayed with calcium sulphide did not present at any time a better appearance than those sprayed with lime-sulphur solution. No spray injury was caused by either the lime-sulphur solution or the calcium sulphide, but the scab control obtained with the latter was inadequate.

The 1-50 lime sulphur trees gave 25 per cent. scabby fruit; the 5-50 calcium sulphide trees, 91 per cent.; and the 10-50 calcium sulphide trees, 79 per cent.

It is believed that the protection obtained with calcium sulphide is much affected by the degree of moisture in the circumambient air and the amount of dew-fall. Cool nights and heavy dews which are common in New Hampshire during the early part of the growing season probably destroy its fungicidal properties rapidly.

Apple-Scab Needs Humidity

Apple scab perithecia do not develop at any temperature when the humidity is less than 90 per cent. saturation, finds S. Dunn; and at 90 per cent. saturation only slight development occurred at 10°C. In a saturated atmosphere, 16 days after storage scabbed leaves developed numerous perithecia at 10°C. and very few at 20°C., but none at 5° to 7°C. or at 8°. *(Hatch Fund)*

Study of Bitter-Pit

Bitter-pit of apples is much worse in years of light crops, observes O. Butler. The trees in all the plots bore heavily in 1930, and the per cent. of bitter-pit in the fruit was low. Up to the present the various fertilizer treatments applied since 1924 have not affected the amount of bitter-pit present, but the addition of lime to a fertilizer has tended to decrease the percentage. The disease is, however, much more affected by the bearing habit of the tree than by the treatments given.

Baldwin apples which at harvest time are quite free from bitter-pit, at times become very badly affected during storage. A study of effect

of date of harvest on the development of bitter-pit during storage showed that fruit harvested October 11 with uniform starch distribution had only two per cent. bitter-pit by January, while fruit harvested October 23 with irregular starch distribution developed 41 per cent. bitter-pit. *(Hatch Fund)*

Oil Sprays

Studies of oil sprays were made by L. S. Groves to determine the cause of toxicity and effect upon the sprayed plant. Highly refined mineral oils suitable for medicinal use were found non-toxic to the plant even when applied undiluted. Neither heavy nor light oil caused any visible injury to the tissues, but both disturb photosynthetic activity even when used at the strength recommended in practice for highly refined petroleum oils. The effect produced increases with the percentage strength in oil of the emulsion; inhibition is virtually complete when strong emulsions or the oils alone are applied.

Oil sprays were also found to reduce the amount of dry matter formed.

Studies on the penetration of the leaf tissue by heavy and light oils showed that penetration was more rapid from the under surface than from the upper. The penetration of the oils was facilitated by the presence of stomata, but they are not essential to it. Upon penetrating into the leaf the oils creep through the intercellular spaces which they fill more or less completely. The replacement of the air in the intercellular spaces by the oil, owing to the high refractive index of the latter, causes light to pass more readily through the leaves and the invaded tissues are thus rendered more translucent. The oils after penetrating the leaf soon reach a state of equilibrium and remain indefinitely in the position first occupied. Translucent spots in leaves sprayed with heavy and light oil emulsions suffer no appreciable change in shape or size with time. The oil remains at the point to which it has penetrated indefinitely. The rate at which heavy and light oils dry do not effect the extent of penetration.

In the studies made with kerosene, on the other hand, it was found that the rate of drying does affect the degree of penetration and the amount of injury ultimately produced. When kerosene is subjected to fractional distillation it will be found that the injuriousness of the fractions obtained decreases with a rise in the boiling point, fractions with high boiling point being even less injurious than the original kerosene itself.

Petroleum-saturated hydrocarbons with a boiling point of 180°C.-200°C. are only very slightly toxic, and the injuriousness of the kerosene fraction that distills between 180°C.-200°C. must be ascribed to the presence of unsaturated hydrocarbons. *(Miscellaneous Income)*

Leafroll and Maturity

Leafroll tends to increase with the maturity of the seed in southern New Hampshire, finds O. Butler, continuing his study of degeneration diseases of the potato. Green Mountain potatoes of the crop of 1929,

showing 1.79 per cent. leafroll, were rogued and dug 80, 90, 101, 110 and 124 days after planting. When used as seed the next year they showed the following respective per cents. of leafroll: 6.0, 12.1, 14.1, 15.3 and 49.7. *(Purnell Fund)*

Burgundy Mixtures

Studies of Burgundy mixtures by O. Butler indicate that calcium arsenate is an extremely effective stabilizer; arsenate of soda is excellent; but lead arsenate is without effect. *(Adams Fund)*

Dye Adsorption by Plants

Hardened plants show a higher adsorption of dyes than do non-hardened plants, finds S. Dunn in studies of cabbage, brussels sprouts and alfalfa. A series of experiments were performed for the purpose of determining the effect of length of time of hardening on colloid content. In general, it was found that dye adsorption increases with length of exposure of the plants to cold up to 4 or 5 days, but that longer exposures cause a decrease, particularly noticeable in plants hardened for 12 days.

It was observed during the course of the experiments that different parts of a given plant not infrequently reacted dissimilarly following the freezing test, whether or not the plant had been previously hardened. In most cases the leaf-blade was more seriously injured than the petiole, or stem.

An attempt was also made to identify more particularly the nature of the colloid or colloids responsible for hardiness. *(Adams Fund)*

European Corn Borer

A steady extension of the one-generation phase of the European corn borer into the western border of New Hampshire is reported by W. C. O'Kane.

In a number of towns the insect now occupies the same territory in which the two-generation phase is found. This brings up the situation anticipated in an earlier report; namely, the possible effect of this mixture of the two phases on future abundance of this insect in New Hampshire. It is possible that the one-generation phase, if it becomes predominant, may turn out to be more destructive than the two-generation phase heretofore present, because the latter has, apparently, tended to be self-limiting through its inability to accommodate itself to the length of the growing season.

It will be necessary to watch the developments closely in the western part of the state, therefore, and to plan future work in accordance with the trends observed there. *(Adams Fund)*

Contact Insecticides

Two principal lines of inquiry have been followed up during the year in the studies of contact insecticides conducted by W. C. O'Kane, W. A. Westgate and E. C. Glover.

Studies of contact angles, as recorded by the special photo-micrographic apparatus developed, led to a plan by which a system of numerical rating was devised, which would indicate the comparative performance of a series of liquids on a given solid. This was worked out mathematically and was published as Technical Bulletin No. 46, "A Numerical Rating for the Contact Performance of a Spray Material." At the close of this publication a table is submitted which derives a definite contact rating from the measured angle of contact. This rating begins at 0, where the angle of contact is 180°, and rises to a rating of 100 for an angle of contact of 1°.

An extensive series of studies and measurements have now been completed with the intent of determining the comparative performance of various so-called "wetting" agents on various typical insects, representing several orders. These studies have involved preparation of accurately appraised materials, their application under control conditions, the record of their performance as indicated by a long series of photomicrographs, numbering several thousand, and finally the correlation of results. The publication is in preparation.

There is a strong tendency at the present time to substitute contact insecticides for stomach poisons in the control of various destructive and widespread insects. Regardless of the nature of the toxic substance employed for bringing about the death of an insect, its performance and efficiency will be strongly influenced by the manner in which the spray is able to extend itself over the surface of the insect and to penetrate into the tracheal tubes, and perhaps its ability to exert its effect on the living insect cells in other ways. A given substance in a given form or medium may be much more toxic than the same substance in a different form or medium. *(Parnell Fund)*

Fertilizer in Orchards

The belief of a few apple growers that it pays to divide the nitrogen application into two parts—half in early spring and half in early summer—is not borne out by a five-year study conducted by G. F. Potter.

Experiments at Durham and Temple with Rhode Island Greening, Baldwin and McIntosh trees showed insignificant variations in the amount of fruit bud formation where two applications were made as compared with the same total in the spring application. There were, to be sure, indications that the percentage of blossoms setting fruit increased slightly; evidently the mid-summer application is stored within the tissues of the tree and is more readily available to the blossoms during the period of fruit setting the following spring than is nitrogen applied on the soil a week or two previous to opening of the bloom; but the difference in yield is doubtful and at best seems not sufficient to justify the trouble.

Studies were also made of plowing in a heavy phosphorus application on seven plots of trees in the Woodman Orchard. Since soil physicists now believe that phosphorus rapidly becomes fixed in the soil and does not move downward appreciably, this phosphorus was

thoroughly incorporated in the surface 8 inches of soil. The orchard was then seeded down in order to allow the roots of the trees to enter the surface layer of soil in which the phosphorus had been incorporated. The amount of phosphorus used was sufficient to increase by from 50 to 100 per cent. the total amount of phosphorus in the surface 8 inches of soil. To date records of yield only have been made in this orchard. The crop of 1930 was heavy and the crops of 1929 and 1931 were light. It is of considerable interest to note that as a three-year average 6 out of 7 pairs of plots receiving phosphorus show a greater yield than the respective controls; the average for the whole group shows an increase of 32 pounds of fruit per tree where the phosphorus is used.

In the opinion of most authorities direct benefit to apple trees from applications of phosphorus has not yet been demonstrated. Statistically the increase of 32 pounds occurring in these plots is too small to form a definite conclusion, yet the indications of benefit from the phosphorus are of very considerable interest. The grass mulch has not been visibly different in the phosphorus and the control plots. If growers are to invest money in phosphorus and potash fertilizer there would seem to be much greater hope for benefit if these materials are incorporated in the soil rather than spread on the surface.

Experiments were continued in three orchards as to the comparative merits of a 5-8-7 complete fertilizer and a mixture of sulphate of ammonia and nitrate of soda containing exactly the same amount of elemental nitrogen per tree. The orchards selected are ones in which for a period of years nitrogen only has been used as a fertilizer. If, by this practice, a deficiency in phosphorus and potash is brought about, such an orchard should be most favorable to determine the value of correcting this deficiency by the application of complete fertilizer. The application of complete fertilizer is carried to a sufficient distance from each tree to insure that all of the area which the roots can penetrate is fertilized. The records include the amount of crop, color and some other factors. Each tree receiving complete fertilizer is compared to a control receiving nitrogen only, situated as close as practicable but in no instance close enough so that the roots of the control tree can enter the area of the soil fertilized with complete fertilizer. In an orchard of mature Baldwins complete fertilizer has shown on a two-year average a rather significant decrease in yield. In one McIntosh orchard a small decrease in yield is experienced, and in the other the yields are almost exactly the same under the two treatments. Considering the fluctuations normally experienced in field tests it is not believed that the decrease in yield is due to the fertilizer, although it is possible that since the nitrogen in the complete fertilizer is not so readily available the trees may have suffered slightly from this fact.

Percentage of color, obtained by estimating the surface covered by a characteristic red on a representative sample of apples from each tree, seems to be in relation to the yield. If yields on plots receiving complete fertilizer are lower the color is better. It is a recognized fact that heavy bearing reduces both size of the individual fruits and color of the crop.

Fruit growers are prone to fear a deficiency of phosphorus and potash in the orchard and frequently spend considerable sums for mixed fertilizer. All of the evidence available to date indicates that at least with a surface application the extra expense is not justified. (*Adams Fund*)

Changes in Apples During Storage

Tests of the keeping quality of Baldwin and McIntosh apples grown under different field conditions and held under various storage conditions were continued by E. J. Rasmussen.

With the Baldwin, differences in lots from different orchards continued to be outstanding. Baldwins from the renovated orchard of the Horticultural Farm kept satisfactorily both at 32° F. and at 30°. Similar Baldwins from the Woodman Orchard failed to attain good flavor at either temperature and at 30° developed a browning about the core.

Baldwins grown on trees in sod fertilized with 10 pounds of nitrate of soda showed no differences in firmness, flavor, ground color, or type of final breakdown from apples grown on trees under similar conditions but which for 12 years have received 7 pounds of acid phosphate and 4 pounds of sulphate of potash per tree applied on the surface of the soil. A slightly higher acidity was noted in the fruit from the complete fertilizer plots.

Baldwins from a cultivated plot in which the trees received 5 pounds nitrate of soda per tree showed no significant differences from those grown on trees in sod receiving 10 pounds of nitrate of soda per tree.

On April 1 Baldwins removed from cold storage and placed in a room at 65° F. lost their crispness in 7 to 10 days, became mealy ripe in 14 days, but were still marketable after 17 to 18 days.

With McIntosh, storage under forced-air circulation gave results identical to those under gravity-air circulation. Since there were but few test boxes, the rate of cooling was about the same in both cases. With large commercial lots, the "blower" cools the fruit from 65° F. to 30° in 48 hours as opposed to 150 under gravity-air circulation in an ordinary room refrigerated with coils on the wall or ceiling. Prompt cooling is usually advantageous, and since in most installations the "blower" is cheaper than the coils, it is to be preferred if results are as good as in the older system of cooling.

Holding McIntosh for 5 days in a room at 65° F. prior to storing did not alter the pressure test, acidity, or ground color, as compared to similar apples cooled immediately after picking. On the other hand, the fruit delayed 5 days showed improvement in flavor and less breakdown due to browning at the core than the apples stored immediately. This trouble appeared February 20 in the fruit stored immediately after picking and by May 20 had affected 95% of the apple. In the fruit delayed 5 days the trouble was not noted until March 10, and on June 25 only 33% of the apples were affected. Breakdown of the outer cortical region of the apple was somewhat increased by delay in storage, 30% of the apples showing this trouble by June 20 against

20% of the apples stored immediately after picking. As is to be expected, holding the apples at 65° for 10 to 20 days after picking caused excessively early ripening and reduced the market period by 50% or more.

On March 6 McIntosh from the lot stored immediately were in fair condition 17 days after being removed from storage and placed in a room at 65° F. Those from the lot delayed 5 days were overripe but edible. On April 6 McIntosh from the lot stored immediately or delayed 5 days remained salable for 18 days after removal from cold storage, the other 2 lots less than 7 days.

McIntosh stored at 30° showed slightly better pressure tests after March 15 than those stored at 32°. In common storage both pressure and acidity dropped rapidly after February 20. The flavor at 32° was rated very good between December 20 and May 1. At 30° the fruit remained rather green up to February 20 and was considered fair until August 20. It never attained the maximum quality.

As in the case of the Baldwin apples, fruit from sod orchards showed no significant difference in storage from fruit from cultivated orchards.

The observation that *if promptly cooled when stored,* holding McIntosh 5 days after picking at 65° reduces brown core and improves flavor, needs to be confirmed by further investigation. If confirmed it means that ordinarily sorting and packing may be done before storing the fruit without fear of deterioration. Fruit may also be moved to storage at the market during this interval. (*Purnell Fund*)

Pollination of Apples

Several of the newer McIntosh and Delicious seedlings were tested as pollenizers by L. P. Latimer in two localities. The results indicate that Medina, Milton, Lobo and Melba are satisfactory pollenizers for the McIntosh and the Cortland. Red Gravenstein, like its parent, is unsatisfactory. Orleans proved satisfactory with the McIntosh but was not tested with the Cortland. As in previous seasons, Delicious proved to be one of the best pollenizers for McIntosh, followed closely by Wagener. Cortland also proved good. The Golden Delicious insured a satisfactory set on the Cortland, but Yellow Transparent did not. Fameuse, tested for the first time this season, gave a very satisfactory set on the McIntosh. It is interesting to note that the seedlings of McIntosh have uniformly proved to be good pollenizers for the parent variety.

Further observations on the relation of pollination to seed formation and the conformation of the fruit agree with those of previous seasons, namely that if an efficient pollenizer is used and a large number of seeds develop the fruit tends to be larger and of more uniform shape. It was again found that fruit developed from the terminal flower of the cluster is 15 to 20 per cent. larger than that produced on lateral blooms. *(Purnell Fund)*

Apples May Need Washing

Baths for apples must be given careful consideration by commercial growers, according to a three-year study of spray residues just completed by G. F. Potter and G. P. Percival.

Arsenical residues were determined on Baldwin apples receiving one, two or three cover sprays in the seasons of 1927, 1928, and 1929. The results indicate that if more than one cover spray is applied and if the season has less than normal rainfall, there is danger of residues existing greater than are permitted in foreign shipments or interstate shipments of apples.

This fact is of greatest significance to fruit growers since shipments found to exceed the tolerance may be confiscated. Publication of this work is contemplated prior to the 1932 harvest season. A service to fruit growers by means of which orchardists, who fear excessive residues, may obtain inspection and determine the necessity for washing or cleaning fruit may need to be instituted. *(Purnell Fund)*

Acid Phosphate Helps Strawberries

Some indication that acid phosphate is beneficial to strawberries appeared in the quadruplicate plots supervised by L. P. Latimer.

The series of plots receiving 1,500 pounds of acid phosphate yielded 18% more than the check, those receiving 1,000 pounds 9% more, and those receiving 500 pounds 5% more. Plots to which 1,000 pounds of potassium chloride have been applied annually for 9 years showed a marked decrease in yield, nearly 30% under the checks. *(Hatch Fund)*

Plant Breeding

In an effort to determine the effect of environment on seed of representative vegetables—hulless popcorn, Bonny Best tomatoes, and Emerald Gem muskmelons of the same strains were grown by J. R. Hepler from seed harvested locally and from seed produced in South Carolina. The popcorn from New Hampshire seed averaged 49.6 inches in height, an increase of 8.6 inches, or approximately 20% over that grown from South Carolina seed. No significant differences in the total amount of vine growth, number of melons per plant, or size of melon was observed. Owing to adverse conditions no measurements were made on the tomatoes, but the plants from the South Carolina strain appeared to be more vigorous than those from the New Hampshire seed.

Tests of several varieties of sweet corn were continued as in 1930. Spanish Gold from the Connecticut Agricultural Experiment Station appeared to be a very promising early yellow sweet corn for this territory. Gill's Golden Early Market also appeared promising, ripening at nearly the same date but being rated slightly lower in quality. Golden Bantam hybrids from the Indiana Station were of good quality but late maturing. In variety tests of tomatoes the new Break-o-day looked promising, having good size, color, and shape. The Shirley strain of Bonny Best also showed up well. *(Hatch Fund)*

Spray Service

Codling moths were trapped in one orchard in each of four of the principal apple producing towns by E. J. Rasmussen. Emergence varied in the different localities as indicated by a catch of 1,124 moths in one orchard, 687 in another, 172 in the third, and 12 in the fourth. Counts indicate that side-worm injury is correlated with the number of moths caught, although in the orchards where moths were abundant the growers applied additional cover sprays.

Apple maggot flies were found to emerge most abundantly from the ground beneath the trees heavily laden with Red Astrachan in 1930. The first flies appeared July 12, the last July 26, with the peak of emergence July 15. There were no traps under trees of Wealthy and McIntosh which had showed infestation in 1930.

Drops of McIntosh infested with railroad worm were placed in cold storage and examined at intervals of 12, 21, and 36 days. No live worms were found after 36 days' storage at either temperature and but very few after 21 days. The insect thrives in common storage. *(State Fund)*

Lettuce in White Mountains

Despite elements of promise in the Iceberg lettuce experiments at Lancaster we are not yet ready to recommend the crop for large-scale production in the White Mountain area.

Considerable difficulty with tipburn was experienced during the past season. Observations in the lettuce-growing districts of the west have led to the conclusion that a high night temperature is responsible for tipburn. In 1931 the thermometer ran above 60° on 28 nights. Some tipburn also developed in 1929 when there were 9 nights above 60°. In 1930 with prevailing cool weather no tipburn appeared although there were 12 nights with that temperature.

The situation is complicated by many factors, which will be discussed in a separate publication shortly. *(Purnell Fund)*

Blueberry Investigations

Field observations by L. P. Latimer indicate that the most successful blueberry farms in New Hampshire are found on hardwood land at elevations from 1,000 to 2,000 feet. Especially favorable conditions are furnished when a fairly shallow and rather acid soil (pH 4.5 to 5.0) with a good underground supply of water overlies granite ledges.

The fruit is mostly of the low bush type, *Vaccinium pennsylvanium,* but in deep soil *V. corymbosum* grows well. With both species there is a variety of types, fruit ranging in size from an elderberry to a hazelnut, varying in shade of color from black to pale blue with and without bloom, in single fruits to large clusters, with insipid to very acid flavor, soft, firm in texture, early, late, and variable in ripening period. Propagation of some of the superior types appears to be a promising field.

Culture generally consists of a triennial burning over. This does not control all weeds and indeed favors the development of certain ones such as brakes, sweet fern, popel, lambkill and iron weed. Diseases and insects are not as yet a serious economic factor although the blueberry maggot is present. Lack of moisture and lack of fertility are sometimes limiting factors.

Many growers are satisfied with existing conditions although it would appear that better management would lower costs. *(Hatch Fund)*

Pre-Cooling Milk

Investigations on pre-cooling of milk have been continued by W. T. Ackerman and H. C. Moore with the finding that the condition of the cans used is an important factor. On some farms the cans proved to be a very serious source of bacteria and the sole reason why the farmers could not produce quality milk. Tests showed that only 3 cans out of 52 were sufficiently free from bacteria. One farmer, using an electric five-gallon hot-water heater at a cost of 10 cents a day for current, was conditioning his cans after they were returned to him by rinsing them with boiling water. *(Purnell Fund)*

Development of White Pine Stands

Plots of immature white pine, ranging from 10 to 50 years, are being studied by K. W. Woodward as to the results of thinning and pruning over a long period of time. Changes of fauna and flora will be traced in another series of plots, recently established.

A group of young mixed plots have been observed for the effect of attacks of the Cottontail rabbit. Blue beech, hazelnut and staghorn sumac were attacked approximately 100 per cent. Red maple and red oak were also badly damaged, but no harm was done to white pine, hemlock or gray birch. Trees two inches and over in diameter seem to be safe, while sprouts have but slight chance of surviving. This points to the conclusion that the species attacked will eventually be removed from the stand. *(Hatch Fund)*

Root Growth of Pine

A two-year investigation of the rate of growth of lateral roots of white pine has been completed by C. L. Stevens in collaboration with Yale University, and Bulletin No. 32 has been issued on the work by the Yale School of Forestry. The pine were four to six years of age, planted in open fields.

In spring and autumn it was found that the growth of the roots was rapid. The most vigorous ones showed a distinct tendency to slow down during midsummer; the less vigorous ceased growth altogether. Changes in the rate of development during the growing season appear to be due to internal causes or to a combination of environmental factors rather than to midsummer drought.

Height growth of the parts above ground was practically complete when the rate of root growth slackened in midsummer. There is no

apparent correlation between the amount of root growth and the amount of top growth, although vigorous tops usually go with rapidly growing root systems.

The roots of trees in the open showed no growth from November 15 to April 1. The roots of a four-year-old tree kept in the greenhouse grew approximately as fast in winter as in summer.

Six-year-old trees averaged a root growth of 18 to 20 inches on sandy soil and 5 to 10 inches on clayey soil.

With four-year-old white pine set six feet apart on sandy soil, root competition may be expected to start within five years after planting. On a clayey soil it is delayed until about the tenth year.

Failures in plantations should be replaced not later than one year after the trees are set out, and the stock used should be of the same age as that in the successful parts of the plantations.

Investigation of a few roots of white pine, gray birch, red cedar, and common juniper indicates that the white pine is best adapted to invade the soil of abandoned pastures, and will ordinarily survive in competition with these three species. Further work along this problem will include other trees and plants usually found on such sites. *(Hatch Fund)*

Formation of Forest Soils

Rate of Deposition of Litter. Studies in the formation of forest soils show decided variations in the rate at which litter is deposited under different types of forest. Six months of preliminary investigation gave the following monthly accumulation in pounds per acre, dry weight, for old conifers, mixed hardwoods, and gray birch: June—189.69, 49.08, and 91.98, respectively, July—152.12, 76.29, 195.36; August—144.65, 37.6, 939.52; September—379.17, 101.19, 267.96; October—1,254.23, 1,757.55, birch not measured; November and December—214.5, 201.18, birch not measured. *(Hatch Fund)*

Acidity of Autumn Leaves. Least acidity of autumnal-colored leaves was found in those of the species hop hornbeam. The aspens ranked next, beech third, and others in the order given: black birch, gray birch, red oak, white oak, Scotch pine, sugar maple, blue beech, Norway spruce red maple, white elm, red pine, and white pine. Hop hornbeam, beech and black birch would appear to be of some assistance in controlling soil acidity under coniferous stands. *(Hatch Fund)*

Mapping Land Uses

A study of land utilization in the town of Durham was completed by C. E. Walker and published in Bulletin No. 255. In addition, an estimate of the timber and the distribution of age classes were included. The study of the tillage and pasture uses was only preliminary. A similar mapping of the town of Fremont was also done, but with particular emphasis on ownership and boundary lines. The two studies indicate that comparatively large areas can be mapped for approximately 10 cents per acre. This would include a rough estimate

of the timber, the distribution of age classes, the delimitation of the boundaries between owners, and the division of the area into land uses. *(Purnell Fund)*

Measuring Vitamin A Requirements

Although more than one per cent. cod-liver oil in the ration now appears to retard the growth of chicks, research has not yet shown how much oil is needed to meet their vitamin A requirements. As much as three per cent. has already been given. Four and five per cent. will be tried during 1932. Since the number of units of vitamin A in the oil is definitely known, an exact measure should soon be made. Then other feeds carrying vitamin A can be substituted for the growth-retarding oil; for instance, alfalfa-leaf meal or yellow corn meal.

The determination of the vitamin A requirements of chicks is important. Healthy chicks cannot withstand a deficiency of this vitamin for more than a few weeks of the initial growth period.

In the experimental work in 1931, several groups of chicks were used. One was fed the New England college conference ration, another a ration entirely lacking in vitamin A, others a vitamin A deficient ration with one, two, and three per cent. cod-liver oil. Each lot was weighed weekly. All made similar growth the first six weeks, but the group given the conference ration, which includes one per cent. of cod-liver oil, forged ahead and finished the experimental period far in advance of the others. The group getting three per cent. oil was greatly slowed down in development. Kidney injury was also noticed in all groups, except the one of the conference ration. Each group was given the same irradiation from an ultra-violet lamp each day to insure sufficient vitamin D. The work was done by A. E. Tepper, H. O. Stuart, T. B. Charles. *(Purnell Fund)*

Comparison of Brooder Temperatures

High brooding temperature in the heated-room type of battery brooder produces greater growth and means smaller loss in both light and heavy breeds of chicks, according to trials with starting temperatures of 90 and 95 degrees, which were reduced five degrees each week during a six-weeks' period.

Under the lower temperatures the heavier breeds of chicks—New Hampshire Reds and Barred Plymouth Rocks—made slower gains per week and were lighter at the end of six weeks than the same breeds under the higher temperatures. The mortality of the lower-temperature group was seven per cent., as compared with only two per cent. for the higher temperature.

The lighter breeds responded similarly, although they were a bit slower in starting under the higher temperatures. By the end of the third week they were ahead of the lower-temperatures group and held this lead throughout the remainder of the period. A. E. Tepper, H. O. Stuart, T. B. Charles. *(Purnell Fund)*

Added Protein Boosts Gains

Rations with a protein content of 17 to 20 per cent. produced greater gains in battery-brooded chicks than those with only 15 or 16 per cent. of protein. Six groups of approximately 60 chicks each were used in this investigation, which continued over a 12-weeks' period. All the chicks in the four groups getting from 17 to 20 per cent. protein weighed over two pounds apiece at the close, with the 20 per cent. group leading in weight. The chicks getting less than 17 per cent. protein averaged under two pounds. A conclusion is that protein levels for battery brooding of chicks appear to be higher than for floor brooding as commonly used. A. E. Tepper, H. O. Stuart, T. B. Charles. *(Purnell Fund)*

Pullorum Disease Testing

With a total of 171,366 tests made for pullorum disease in poultry during the 1930-31 season, an increase of approximately 21,000 tests was recorded over the previous year. The results of the testing are reported by C. A. Bottorff as follows:

Kind of Flocks	*No. Flocks*	*No. Birds*	*No. Reactors*
Accredited,	67	70,412	none
100% Free,	66	42,565	none
Part 100% Free,	21	11,465	none
Part 100% Test with Reactors,	10	11,172	495
100% Test with Reactors,	26	35,752	1,129
TOTALS,	190	171,366	1,624

(Miscellaneous Income)

Observing Spread of Pullorum Disease

To observe the transmission or spread of pullorum disease, 50 non-reacting birds from the University poultry farm were ranged and housed with 12 reacting birds that came from a badly infected source. At the end of the three months four per cent. of the original non-infected birds had contracted the disease and 12 per cent. of them in 11 months. This shows that the rate of transmission of pullorum disease is slow in semi-mature and adult stock. C. A. Bottorff. *(Purnell Fund)*

Eradicating Pullorum Disease

Two flocks totaling about 1,500 birds were used by C. A. Bottorff to conduct tests for the eradication of pullorum disease. Present conclusions are that while early pullet testing will remove a large percentage of the reactors in a highly infected flock, all the birds must be laying before the infection can be completely eradicated by the agglutination test. The use of formaldehyde gas is recommended for disinfecting incubators to reduce the spread of the disease.

One of the flocks selected for the studies had a very high mortality record for its hatches. Before any testing was done on it, two lots of

nearly 600 chicks each were entirely lost due to the transmission of the disease from parent stock to progeny. The lowest mortality of the next three hatches was 93 per cent. The incubator was treated with formaldehyde gas and the mortality of the following hatch dropped to 37 per cent.

The parent flock was then tested and 120 reactors removed. The mortality of the next hatch up to three weeks—the period on which all the mortality figures in this research are based—had dropped to 15 per cent. Testing had begun in March. By October the flock was entirely free from the disease, a total of 156 reactors having been removed from the original 500 birds.

The young stock produced from this flock was also under test, beginning at approximately three months of age. Nearly 200 of the flock of 700 were eliminated as reactors. The 800 progeny of this second generation were tested at the age of seven months and found 100 per cent. free from the disease.

A second adult flock of nearly 1,000 was divided into five groups of hens, young cockerels, and pullets hatched at various periods the preceding spring. These were tested monthly for about eight months and more than 650 reactors removed. About six months later another series of four monthly tests was made and complete freedom from pullorum disease definitely established. *(Purnell Fund)*

Study of Paralysis of Poultry

Paralysis of poultry is being investigated by C. L. Martin and A. E. Tepper through a study of the blood and bones of mature birds. The work the past year was confined to blood counting. Chemical analyses will be repeated. Then the birds will be killed and a sectional study made of their intestines, liver and pancreas. *(Purnell Fund)*

Vaccinating for Fowl-Pox

Skin vaccination for the prevention of fowl-pox with a non-attenuated virus, was continued throughout the year by C. L. Martin and C. A. Bottorff. The improved "stab" method was used successfully for the second consecutive year. To determine the best storage for fowl-pox virus so that its virulency may be maintained, it was stored in the form of ground and unground scabs in air-tight containers at ice-box and at room temperatures. It is tested monthly. *(Purnell Fund)*

Testing for Contagious Abortion

Efforts to control contagious abortion in cattle through the use of the agglutination test have shown the same good results as in the past, reports C. L. Martin. Herds rid of positive reactors have remained free from the disease as evidenced by negative tests. Other herds with the reactors segregated in the same stable have gradually been able to replace the infected animals with non-infected home-raised heifers. It is expected that by following this practice a clean herd will result in due time, and apparently at very little expense to the dairyman.

Veterinarians submitted 3,345 samples to our pathological labora-

tory for testing for Bang's disease by the agglutination method. The number from New Hampshire was 2,636 and the percentage of infection, 12.29. *(Purnell Fund)*

Autopsies Show Worst Poultry Diseases

Coccidiosis caused the greatest loss of adult birds and pneumonia the death of the largest number of young chickens, according to autopsy work done during the year by C. L. Martin and C. A. Bottorff.

The more serious losses of adult birds were as follows: 246 from coccidiosis, 113 from ruptured egg yolk, 58 round worms, 47 pneumonia, 20 pullorum disease, 20 indigestion, 19 colds, 19 tape worms, and 170 from a variety of other causes, including tumor, fine sand, fowl-pox, paralysis, vent gleet, staphlococcus infection, lice and mites, and enteritis.

Pneumonia took 603 chicks, pullorum disease 264, coccidiosis 173, indigestion 46, sour crop 44, colds 38, rickets 21, and such other troubles as enteritis, toxic poisoning, faulty incubation, impaction, bronchitis, urea poisoning, slipped tendon, vitamin D deficiency, a total of 177 more.

Autopsies of turkeys revealed that the loss of 13 was due to pullorum disease, 7 to pneumonia, 6 coccidiosis, 3 blackhead.

By means of its autopsy service the experiment station is able to keep in close touch with the animal diseases throughout the state. *(Miscellaneous Income)*

Fowl-Pox Vaccine

New Hampshire poultrymen with 42 flocks applied for 67,350 doses of fowl-pox vaccine. A total of 30,600 doses were shipped outside of the state, as far west as Iowa, south to Virginia, and north to Ontario. *(Miscellaneous Income)*

Poultry Certification Continues

The poultry certification program inaugurated in 1927-28 is now in its fifth year of operation under the original rules. Approximately 20,000 birds were handled and classified by the inspector the first year, about 40,000 the second and third years, and about 35,000 in 1930-31.

Due to economic conditions a decline in the number is anticipated this year. Up to the present time 23,871 birds have been handled in comparison with 26,363 during the same period a year ago. A. E. Tepper has been in charge of the work. *(Miscellaneous Income)*

Inspection Service

Seed. The regular seed inspection work for the State Department of Agriculture was conducted as usual. During the season 1931, 437 samples of seed were handled in the laboratory; of this number 385 were collected by the State Inspector and are reported in Bulletin No. 258. The remaining fifty-two samples were sent in by private individuals or by members of the Extension service staff. The analytical work, the compilation of the tables and the preparation of the bulletin was handled by Mrs. B. G. Sanborn, and L. J. Higgins.

Feeding Stuffs. In the enforcement of the law regulating the sale of concentrated commercial feeding stuffs 390 brands were analyzed by T. O. Smith and S. I. Fisher for the State Department of Agriculture. These analyses required about 3,100 individual determinations.

Fertilizers. In the enforcement of the law regulating the sale of commercial fertilizers 117 brands were analyzed for the State Department of Agriculture. These analyses required about 800 individual determinations.

Samples of soils, feeds, fertilizers, laundry soaps, poisons and other materials were sent to the Station's chemical laboratory by residents of the state. Of these 129 have been analyzed involving about 190 individual determinations. *(Miscellaneous Income)*

Seed Certification. Potato growers entered 107 acres of Green Mountain potatoes for certification in 1930, and 92 acres were passed.

Advanced Register Tests. Advanced register tests were supervised during the year, as follows: 113 cows on 6 farms, Ayrshires; 155 cows on 10 farms, Guernsey; 106 cows on 4 farms, Holsteins; 60 cows, 2 farms, Holstein; 29 cows, 3 farms, Jerseys; 48 cows, 1 farm, Shorthorns; retests of 20 cows for advanced register. *(Miscellaneous Income)*

FINANCIAL STATEMENT

Expenditures of the New Hampshire Agricultural Experiment Station for the Year Ending June 30, 1931

	Hatch Fund	Adams Fund	Purnell Fund	Supplementary*	Total
Salaries	$9,672.70	$12,303.52	$43,820.47	$21,547.86	$87,344.55
Labor	638.52	223.53	4,000.99	6,389.08	11,252.12
Stationery and office supplies	233.16	19.40	240.65	188.16	681.37
Scientific supplies, consumable	24.64	110.96	963.17	1,674.91	2,773.68
Feeding stuffs	.....	451.38	204.56	495.35	1,151.29
Sundry supplies	149.69	58.78	1,054.19	6,687.97	7,950.63
Fertilizers	104.83	.....	453.61	349.06	907.50
Communication service	523.04	.....	40.12	233.59	796.75
Travel expenses	621.37	107.82	3,136.10	4,487.68	8,352.97
Transportation of things	329.54	18.09	151.22	879.33	1,378.18
Publications	592.04	(Omit)	1,254.93	698.14	2,545.11
Heat, light, water, and power	700.00	.....	.....	7.50	707.50
Furniture, furnishings, fixtures	7.48	8.70	190.16	180.85	387.19
Library	600.27	.....	23.40	141.33	765.00
Scientific equipment	395.66	1,069.55	2,170.93	752.56	4,388.70
Livestock	.....	.....	35.00	20.40	55.40
Tools, machinery, appliances	393.86	29.46	1,223.64	445.26	2,092.22
Buildings and land	.....	598.81	931.88	204.42	1,735.11
Contingent expenses	13.20	.....	104.98	514.76	632.94
Unexpended balance	.....	.....	.....	9,871.24	9,871.24
Totals	$15,000.00	$15,000.00	$60,000.00	$55,769.45	$145,769.45

*This fund includes expenditures from the following sources:

State appropriations	$ 5,800.00
Sales and miscellaneous income	49,969.45
	$55,769.45

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION STAFF

Administration

EDWARD M. LEWIS, A.M., LL.D., Litt.D., *President*
JOHN C. KENDALL, B.S., *Director*
HENRY B. STEVENS, A.B., *Agricultural Editor and Executive Secretary*
F. E. PERKINS, B.S., *Editorial Assistant*
RAYMOND C. MAGRATH, *Treasurer and Business Secretary*
WILLIAM W. SHIRLEY, B.S., *Librarian*

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TODD O. SMITH, M.S., *Associate Chemist*
STANLEY R. SHIMER, M.S., *Assistant Chemist*
GORDON P. PERCIVAL, M.S., *Assistant Chemist*
SAMUEL J. FISHER, B.S., *Graduate Assistant in Agricultural Chemistry*

Agricultural Economics

HARRY C. WOODWORTH, M.S., *Agricultural Economist*
M. GALE EASTMAN, Ph.D., *Associate Agricultural Economist*
MAX F. ABELL, Ph.D., *Assistant Agricultural Economist*
EARL H. RINEAR, M.S., *Specialist in Marketing*
CHARLES W. HARRIS, JR., B.S., *Assistant in Agricultural Economics Research*

Agronomy

FREDERICK W. TAYLOR, B.S., *Agronomist*
FORD S. PRINCE, B.S., *Associate Agronomist*
PAUL T. BLOOD, M.S., *Assistant Agronomist*
LEROY J. HIGGINS, B.S., *Assistant Agronomist*
BETTY G. SANBORN, *Seed Analyst and Stenographer*

Animal Husbandry

ERNEST G. RITZMAN, M.S., *Research Professor in Animal Husbandry*
NICHOLAS F. COLOVOS, M.S., *Assistant in Animal Husbandry*
CLARENCE WINCHESTER, B.S., *Graduate Research Assistant in Animal Husbandry*
LLOYD WASHBURN, B.S., *Graduate Research Assistant in Animal Husbandry*
ALBERT D. LITTLEHALE, *Shepherd*
HELEN H. LATIMER, *Gas Analyst*

Botany

ORMOND R. BUTLER, Ph.D., *Botanist*
STUART DUNN, M.S., *Assistant Botanist*
RUSSELL BISSEY, M.S., *Research Assistant in Botany*

Dairy

JOHN M. FULLER, B.S., *Dairy Husbandman*
HERBERT C. MOORE, M.S., *Assistant Dairy Husbandman*

Rural Electricity

WALTER T. ACKERMAN, B.S., *Specialist in Rural Electricity*

Entomology

WALTER C. O'KANE, M.A., *Entomologist*
JAMES G. CONKLIN, M.S., *Assistant Entomologist*
LEON C. GLOVER, M.S., *Research Assistant in Entomology*
WARREN A. WESTGATE, M.S., *Research Chemical Assistant in Entomology*

Forestry

KARL W. WOODWARD, A.B., M.F., *Forester*
CLARK L. STEVENS, Ph.D., M.F., *Assistant Forester*

Horticulture

George F. Potter, Ph.D., *Horticulturist*
J. R. Hepler, M.S., *Associate Horticulturist*
L. Phelps Latimer, Ph.D., *Assistant Horticulturist*
E. J. Rasmussen, M.S., *Research Assistant in Horticulture*
Roland B. Dearborn, M.S., *Assistant in Vegetable Gardening*
Neil W. Stuart, B.S., *Graduate Assistant in Horticulture*
James Macfarlane, *Florist*

Poultry

Thomas B. Charles, B.S., *Poultry Husbandman*
Albert E. Tepper, M.S., *Assistant Poultry Husbandman*
Carl L. Martin, D.V.M., *Veterinarian*
Charles A. Bottorff, Jr., D.V.M., *Poultry Pathologist*
Frank D. Reed, B.S., *Poultry Certification Inspector*
Elmer W. Lang, *White Diarrhea Tester*
Roslyn C. Durgin, B.S., *Assistant Poultry Tester*
Roger C. Ham, *Laboratory Technician in Poultry Husbandry*
Sara M. Sanborn, *Laboratory Technician in Poultry Husbandry*

Assistants to the Staff

Beatrice M. Richmond, *Bookkeeper*
Elizabeth E. Mehaffey, *Assistant Librarian and Mailing Clerk*
Maisie C. Burpee, *Secretary to the Director*
Martha E. Fisher, *Stenographer*
Christina M. Collins, *Stenographer*
Kathrina Legg, *Stenographer*
Nettie Durgin, *Clerk*
Margaret J. Blood, *Stenographer*
Phyllis Seymour, *Stenographer*
Marion Hutchins, *Stenographer*
Gladys S. Reed, *Stenographer*
Margaret Rose, *Stenographer*
Amber Hall, *Stenographer*